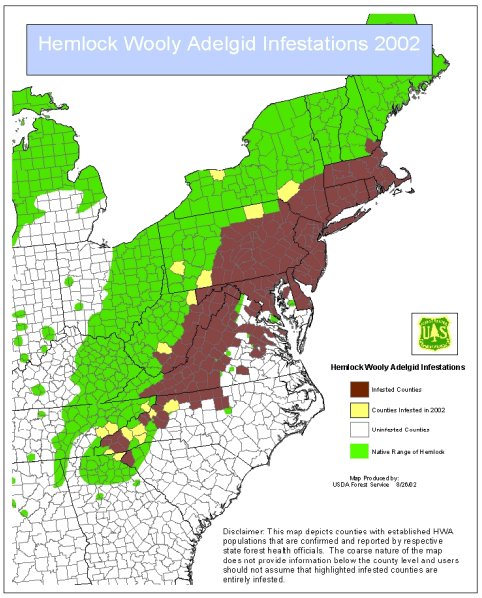
HEMLOCK WOOLY ADELGID, A MORTAL THREAT TO APPALACHIAN HEMLOCK FORESTS

Hemlocks killed by hemlock wooly adelgid. (*Photo Lackawanna River Corridor Association)*

The hemlock wooly adelgid (HWA) is the most serious threat to Appalachian forests since the chestnut blight epidemic more than 60 years ago. Nearly half of the eastern hemlock forest stands are now infested with this tiny insect, a relative of aphids and scale insects. It is just now beginning to infest the ancient forests of the Smokies and southern Appalachians, but already has caused extensive tree mortality in the middle Atlantic and southern New England states. In New Jersey, nearly all hemlock stands (26,000 acres) are considered irreversibly damaged. The insect extracts the nutritious sap of the trees, weakening them beyond recovery in as little as three years. The U.S. Forest Service estimates that the entire range of Eastern hemlock will be infested in the next several decades.

HWA can be controlled in two ways: injected or spray-on insecticides, and biological control by a tiny lady beetle. Insecticide treatment is feasible only for small groups, specimen trees, and areas of high public use or visibility. The vast majority of hemlocks are in regions not open to motorized vehicles or heavy equipment, and so must be treated with the beetle. Beetles can be reared in the laboratory but this process is labor-intensive and expensive.



Natural hemlock range (green), HWA distribution (maroon), new infestations (yellow). (*2002 Map U.S. Forest Service*)

Impacts of HWA on Quality of Life:

- All Eastern and Carolina hemlocks are very susceptible to the adelgid.

- Hemlocks are hugely important to the stability of ecosystems in the southeastern United States. These trees stabilize the soil, provide dense shade that lowers water temperatures in streams as much as 6-8° F, and serve as cover and forage for many species of birds and wildlife. Some hemlocks in this region are up to 800 years old. Hemlocks are among the few truly irreplaceable parts of their ecosystem. Stately, cathedral-like hemlocks engender unmatched feelings of tranquility in humans.

- Hemlocks cover 3,820 acres of Great Smoky Mountains National Park, mostly in virgin forests and as irreplaceable shade trees along mountain streams. Some Park hemlocks are more than 400 years old.

- Hemlocks may be an important resource tree for bioactive natural products. Native Americans used hemlock constituents for rheumatism, colds, fevers, diarrhea, coughs, scurvy, and stomach troubles.

Heavy infestation of hemlock wooly adelgid. (*Photo U.S. Forest Service*)

***Pseudoscymnus tsugae*, a predatory lady beetle feeding on HWA. (*Photo C. Cheah, U.S. Forest Service*)**

- Hemlock is an important and versatile lumber tree, with about 4.16 million cubic meters harvested each year.

- Hemlocks are among the most important ornamental trees. Nearly 300 hemlock cultivars are grown in plant nurseries, which in North Carolina and Tennessee accounts for more than $30 million in annual sales.

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ROLE OF THE TENNESSEE AGRICULTURAL EXPERIMENT STATION AND INSTITUTE OF AGRICULTURE

The University of Tennessee is assembling a team of scientists to attack the hemlock wooly adelgid problem from many angles. We will be looking for new and creative ways to manage this pest based on the fact that none of the traditional methodologies have been successful enough to offset significant economic and environmental damage. We will focus on integrated management of the adelgid, using both basic and applied techniques to address this problem.

ACTIVITIES AND RESEARCH PRIORITIES

1) Beetle rearing facility: Predatory beetles (*Pseudoscymnus tsugae*) are urgently needed in order to make releases to slow the invasion of the adelgid. Supplies of beetles from existing facilities are in extremely short supply due to the intensive training and labor required to produce them. A regional approach to beetle roduction is the most feasible way to get beetles for an area, but no facility yet exists in the Smokies-southern Appalachian area for beetle production. In the long run, diverse techniques will be needed to manage the pest. We need research to determine the degree of control that can be expected from single and multiple approaches. Additionally, pests of other components of the ecosystem may arise and require management. Development of a Beneficial Insects Laboratory would allow us to prepare for such events before they become catastrophic. Estimated cost for first-year start-up of a beetle facility is $220,000; beetle rearing will require a 2,400-ft^2 physical facility, with additional space for later expansion (see item 3).

2) Insecticide movement in hemlocks: Several technologies are available to control the adelgid on individual trees. Assessment of these technologies must be made to assure that they actually work, and are used in a manner that will slow the development of resistance to the pesticides in adelgid populations.

3) Assessment of beetle releases: We need to monitor beetle releases to be sure that releases are effective, and that beetles have established and are reproducing. We must address the possibility that more than one biological control agent will be needed to effectively protect the hemlocks against the adelgid. Future releases of other adelgid control agents will need monitoring. Often, two or more organisms feeding on a target insect will have a more dramatic impact on populations of the pest.

4) Adelgid effects on tree physiology: We need to find out much more about the physiological effects of the adelgid on hemlock, the method of feeding and damage, and the host range of the pest. To support this work, we need to establish a hemlock nursery and/or living collection that includes species of the Asian, western North American, and eastern North American hemlock groups.

5) Insect faunas of hemlock: Insect species associated with hemlocks should be surveyed within the various habitats of the southern Appalachians to estimate their role in progression of the adelgid outbreak.

6) Artificial rearing: Currently, the predatory beetle cannot be reared in artificial culture. We need to identify compounds in hemlock (different plant parts) and the adelgid that trigger attraction and feeding of the beetle and its larvae. New artificial diet formulations need to be developed and tested as suitable media for rearing beetles that control the pest as well as naturally reared beetles.

7. Genetic characterization of system components: Genetic characterization of the host and insect will provide answers to why some species of hemlock are susceptible to adelgids while others are either tolerant or resistant. Also, assessment of genetic variability of adelgid populations throughout the infested range of hemlock will help determine how environmental changes are affecting the genetics of adelgids and their predators.

8. Reproductive characteristics of adelgids and predators at differing altitudes in GSMNP: Because the GSMNP region has habitat that mimics climatological and ecological zones of much of the eastern United States, this invasion represents an opportunity to determine what changes in reproduction are generated by genetic variation and which are the result of environmental triggers.